

## A CLIMATOLOGY OF VERY INTENSE TYPHOONS:

OR

## WHERE HAVE ALL THE SUPER TYPHOONS GONE?

LT R. H. BOUCHARD, USN

NOCC/JTWC

**Introduction.** The term super typhoon is a classification applied to tropical cyclones that reach 130 kt sustained one-minute average wind speed. The term is not a World Meteorological Organization (WMO) standard, but is used by the Joint Typhoon Warning Center, Guam (JTWC). In preparing the 1990 Annual Tropical Cyclone Report (ATCR), it was decided to make current A Climatological Study of Super Typhoons published in the 1970 Annual Typhoon Report (ATR, the predecessor of the ATCR) (JTWC, 1970) which included the years 1959-1970. Figures from that climatological study have been republished in various individual storm write-ups in succeeding ATR's/ATCR's and the study is frequently used in intensity forecasting.

At the outset such an update seemed fairly simple - using an interactive climatology of tropical cyclones of the western North Pacific developed by the Technique Development Group, Detachment 1, First Weather Wing, all tropical cyclones meeting the 130-kt criterion from 1971 through 1988 were identified. The 1970 Study identified 70 super typhoons during the period 1959-1970 for an average of 5.8 per year. The 1989 climatological search identified 48 for the period 1971-1988 for an average of 2.7 - less than half the number for the earlier period. Where had all the super typhoons gone?

**Background.** The 1970 Study identified super typhoons by applying the equation developed by Fletcher (1955) which correlated maximum sustained winds with recorded minimum sea-level pressure. The equation gives 944 mb as the equivalent sea-level pressure corresponding to 130 kt. Wind speeds in excess of 100 kt being subjective and the conservative nature of sea-level pressure made it the optimum parameter to use in classifying super typhoons.

The most often cited part of the 1970 Study is the figure depicting areas of  $5^{\circ} \times 5^{\circ}$  squares of first super typhoon intensity occurrences (Figure 1). The 1970 Study found, between the Philippines and the northern Marianas, a double maxima separated by minimum area. The super typhoon maxima were downstream from the minimum sea-level pressure double maxima found by Fung (1970). The 1970 Study also showed that super typhoon occurrence was normally distributed about the peak reached in September.

Subsequently Atkinson and Holliday (1975) developed a relationship between tropical cyclone minimum sea level pressure and maximum sustained winds. That relationship (reinforced by the results of (Lubeck and Shewchuck (1980))) has become the standard relationship used by JTWC since. That relationship equates 130 kt with



approximately 910 mb.

Pressure was routinely available because of the availability of aircraft reconnaissance. Gradually satellite surveillance augmented, then replaced aircraft reconnaissance in 1987. Determination of intensity was either by satellite imagery using the procedures of Dvorak (1973, 1984), or by the occasional surface observation. Because pressure was no longer measured, intensities were determined from the Dvorak scale then pressure is derived from the Atkinson-Holliday relationship.

**Methodology.** Because of the advantages cited by the 1970 Study in using sea-level pressure, it was decided to use sea-level pressure once again to determine intensity. Because of the Atkinson-Holliday standard it was decided to use 910 mb as the criterion for selecting super typhoons; however, because the super typhoon criterion is very specific to 130 kt, the lack of super typhoon intensity data in the Atkinson-Holliday study, and to avoid conflict and confusion with super typhoon classifications within the JTWC and other archives, the term Super Typhoon will not be used instead a generic term - Very Intense Typhoons (VIT) will be used.

Aircraft reconnaissance and satellite surveillance data were culled from the Individual and Consolidated Typhoon Reports from 1950 through 1958 and the ATR's and ATCR's thereafter. All instances of a tropical cyclone reaching a central pressure of 910 mb was classified as a VIT. No attempt was made to determine the location of the first occurrence of 910 mb to other than 5°x5° square unless fix data crossed square boundaries. In those cases the fix data were linearly interpolated to locate the appropriate square. For aircraft fix data only measured central pressure from dropsonde data or the pressure derived from the 700-mb height using the relationship:

$$SLP = 645 + .115 * (700 \text{ mb height in meters})$$

was used. As aircraft data became scarce and was replaced by satellite derived intensities and the Atkinson-Holliday relationship, the first occurrence of 910 mb was taken from the first occurrence of Super Typhoon from the best track data published in the ATCR's.

**Results.** By using the more restrictive criterion of 910 mb, 83 tropical cyclones were classified as VIT's for the period 1950 through 1989 (Table 1). This is an average of 2.2 per year. While the double maxima is no longer evident (Figure 2), an axis of maximum occurrence remains between 15°- 20° north latitudes and there are indications of a primary lobe east 135° with a secondary lobe west of 140° with the axis of maximum occurrence pinched between 135° and 140° in which 48%. The axis of maximum occurrence corresponds to the axis of the Sub-Equatorial Ridge (SER) and is east of the East Asian Trough (EAT) (Guard, 1977).

The 1970 Study had found super typhoons normally distributed about a peak in September. The peak in VIT occurrence is in October (Figures 3 and 4).

There appears to be some consistency in the VIT classification. Despite the changing fix platforms and procedures, the decadal average of VIT's remains relatively constant with the 60's being a below average decade and the 80's an above average decade and the 50's and 70's near average (Figure 5). However, since 1975 at least one VIT has occurred every year. This may be attributable to the advent of the operational availability of satellite derived intensities (Dvorak, 1973).

## REFERENCES

Atkinson, G. D. and C. R. Holliday, 1975: Tropical Cyclone Minimum Sea Level Pressure-Maximum Sustained Wind Relationship for Western North Pacific. NOCC/JTWC, COMNAVMARIANAS Box 12, FPO San Francisco 96630-2926, 20 pp.



Dvorak, V. F., 1973: A Technique for the Analysis and Forecasting of Tropical Cyclone Intensities from Satellite Pictures. NOAA Technical Memorandum NESS 45, 19 pp.

Dvorak, V. F., 1984: Tropical Cyclone Intensity Analysis Using Satellite Data. NOAA Technical Report NESDIS 11, US Department of Commerce, National Oceanic and Atmospheric Administration, National Earth Satellite service, Washington, DC 20233, 46 pp.

Fletcher, R., 1955: Computation of Maximum Surface Winds in Hurricanes. *Bulletin of the American Meteorological Society*, 36, pp. 247-250.

Fung Yat-kong, 1970: A Statistical Analysis of the Intensity of Typhoons: 1958-1968. Tech. Note No. 9, Royal Observatory , Hong Kong.

Guard, C. P., 1977: Operational Application of a Tropical Cyclone Recurvature/Non-recurvature Study Based on 200 mb Wind Fields. FLEWEACEN TECH NOTE: JTWC 77-1. NOCC/JTWC, COMNAVMARIANAS Box 12, FPO San Francisco 96630-2926, 40 pp.

JTWC, 1970: A Climatological Study of Super Typhoons. *Annual Typhoon Report* , pp. 3-35 to 3-41.

Lubeck, O. M. and J. D. Shewchuck, 1980: Tropical Cyclone Minimum Sea Level Pressure Maximum Sustained Wind Relationship. NAVOCEANCOMCEN TECH NOTE: JTWC 80-1, NOCC/JTWC, COMNAVMARIANAS Box 12, FPO San Francisco 96630-2926, 13 pp.

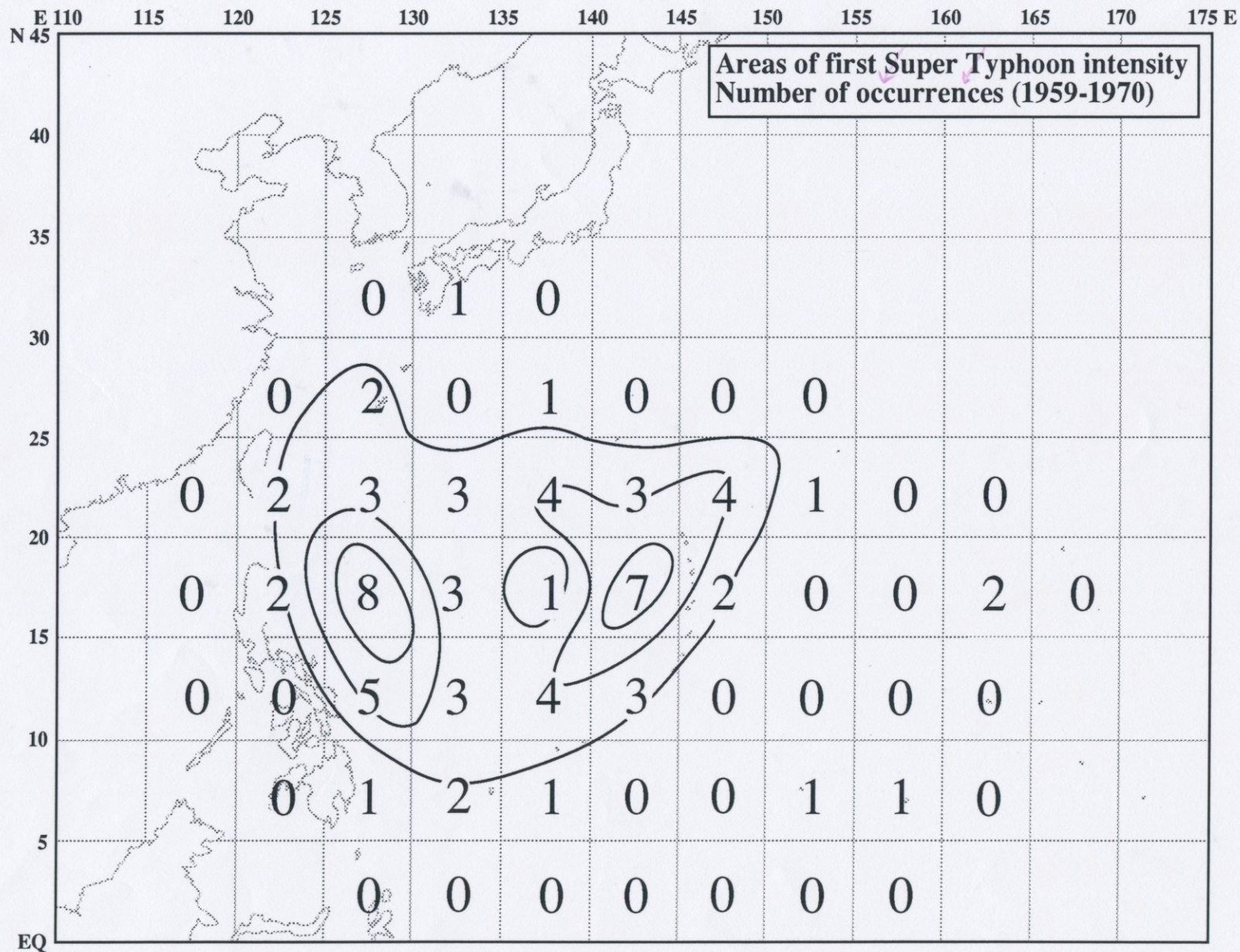


Figure 1



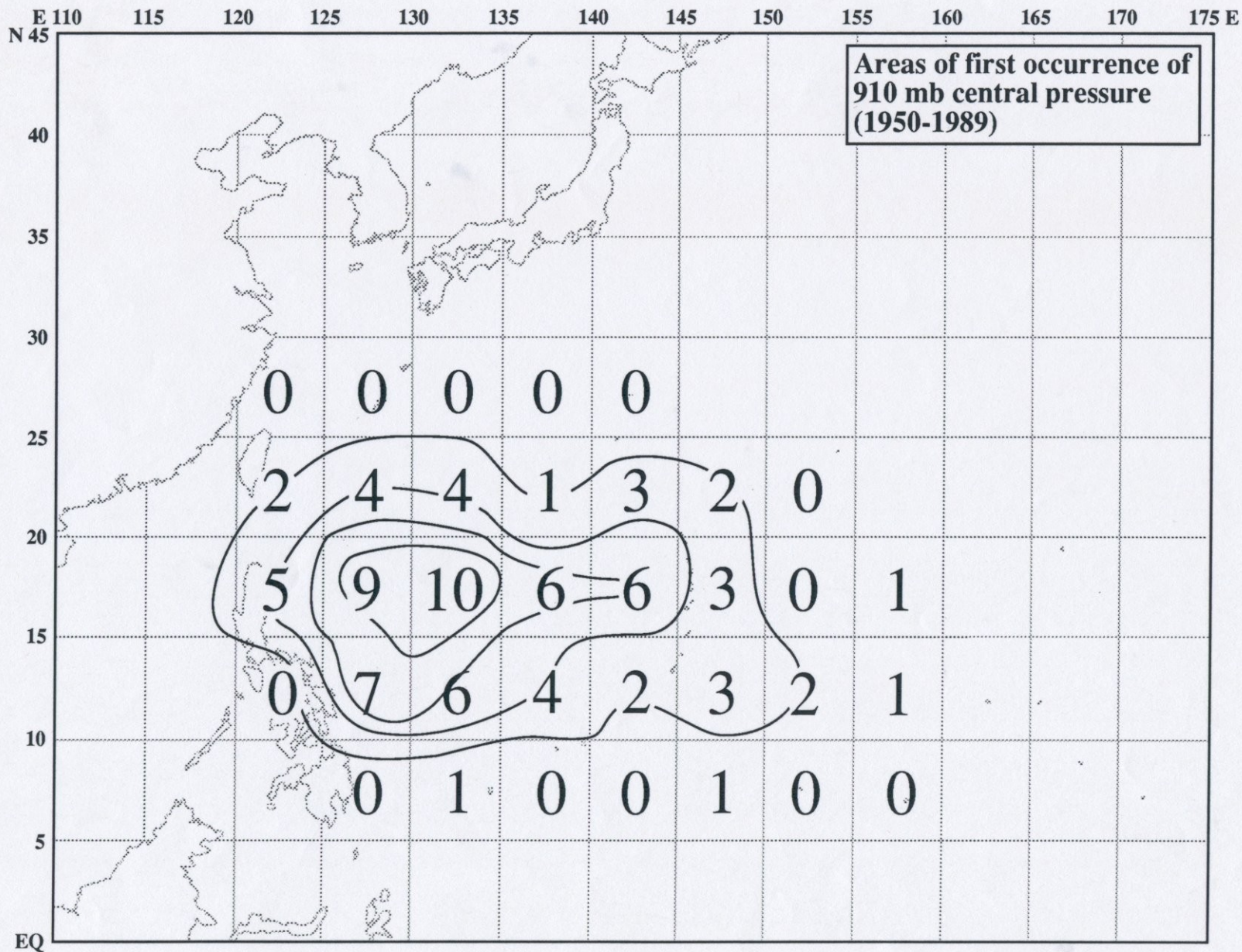


Figure 2.

**NUMBER OF VIT's PER 10  
YEARS FOR EACH MONTH**

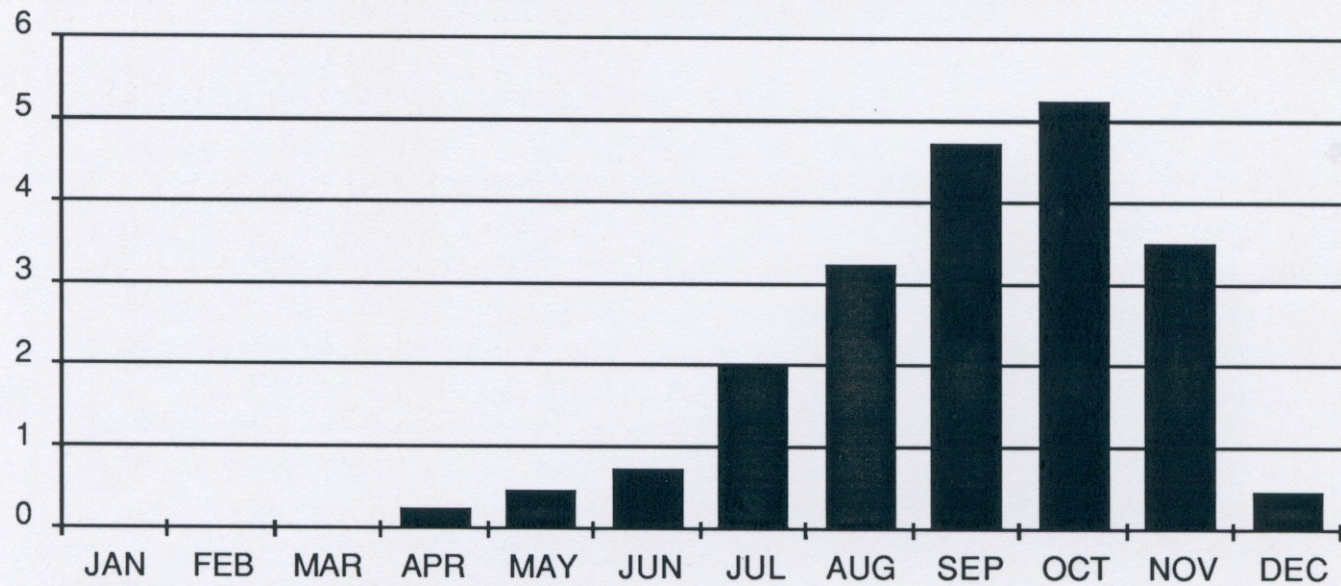
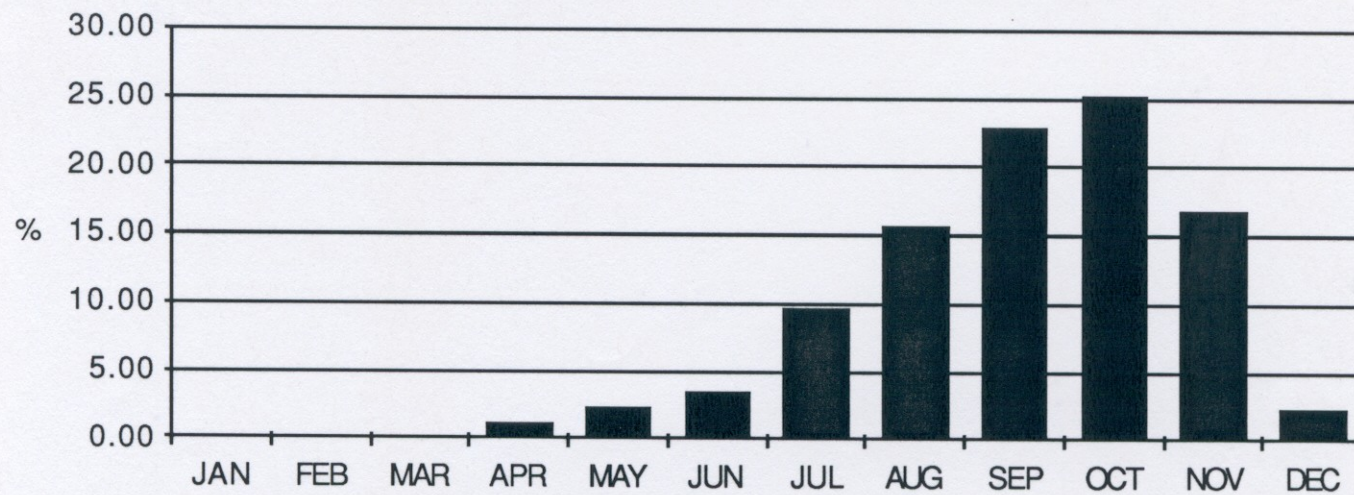


Fig 3



### PERCENTAGE OF VIT's BY MONTH



F194

	A	B	C	D	E
1	NAME	MONTH	MARSDEN SQ	YEAR	LOWEST SLP
2	OPAL	8	962	62	910
3	SHIRLEY	7	962	60	908
4	BETTY	8	961	72	910
5	NINA	8	961	75	904
6	BABE	9	961	77	906
7	SARAH	9	961	59	905
8	AGNES	8	952	57	903
9	TESS	10	952	53	907
10	NINA	8	952	53	910
11	MARGE	8	952	51	908
12	WILDA	9	951	64	905
13	HESTER	10	942	57	886
14	BESS	9	942	65	901
15	JUNE	9	942	54	909
16	HOPE	9	941	70	895
17	EMMA	10	941	62	903
18	GEORGIA	9	604	70	904
19	ELSIE	10	604	75	900
20	KIM	7	604	80	908
21	ELAINE	9	604	68	908
22	ANGELA	9	604	89	
23	OLGA	6	603	70	904
24	VIOLA	7	603	69	897
25	CHARLOTTE	10	603	59	905
26	HOPE	7	603	79	898
27	NESLON	10	603	88	898
28	PAMELA	11	603	54	906
29	CARLA	11	603	50	908
30	GORDON	7	603	79	
31	ELSIE	10	603	89	
32	JOAN	10	601	70	901
33	NORA	10	601	73	877
34	NINA	11	601	87	891
35	BETTY	8	601	87	891
36	VIRGINIA	6	601	57	910
37	EMMA	11	601	67	908
38	TRIX	10	601	54	910
39	JOAN	8	594	59	891
40	NADINE	7	594	71	893
41	PATSY	10	594	73	898
42	ABBY	8	594	83	888
43	MAC	10	594	82	888
44	PEGGY	7	594	86	900
45	DINAH	8	594	87	910
46	GRACE	8	594	58	904
47	IDA	8	594	54	892
48	BESS	11	594	52	910
49	CARLA	10	592	67	901
50	LOUISE	11	592	76	895
51	IRMA	11	592	81	902
52	BILL	11	592	84	909
53	DOT	10	592	85	897
54	KIT	6	592	53	902
55	WYNNE	10	593	80	890
56	AGNES	9	593	68	904
57	FORREST	9	593	83	883
58	MARGE	11	593	83	896
59	IDA	9	593	58	873
60	JUDY	8	593	79	887
61	SALLY	9	591	64	894
62	TIP	10	591	79	870
63	ELSIE	9	591	81	893
64	IRMA	12	591	89	
65	VIOLET	10	584	61	882



	A	B	C	D	E
6 6	VERA	9	584	59	896
6 7	LYNN	10	584	87	898
6 8	MAC	10	584	82	895
6 9	NANCY	9	584	61	882
7 0	GILDA	11	584	67	890
7 1	ELSIE	9	583	69	890
7 2	KIM	12	583	86	905
7 3	BESS	9	583	79	901
7 4	HOLLY	9	573	87	898
7 5	JUNE	11	582	75	876
7 6	ANDY	4	582	89	
7 7	THERESE	7	581	76	903
7 8	VANESSA	10	581	84	879
7 9	LOLA	11	581	57	896
8 0	RITA	10	572	78	878
8 1	KAREN	11	572	62	897
8 2	LOLA	5	571	86	910
8 3	OPAL	11	234	64	903
8 4	AMY	5	223	71	895

# VIT's PER YEAR

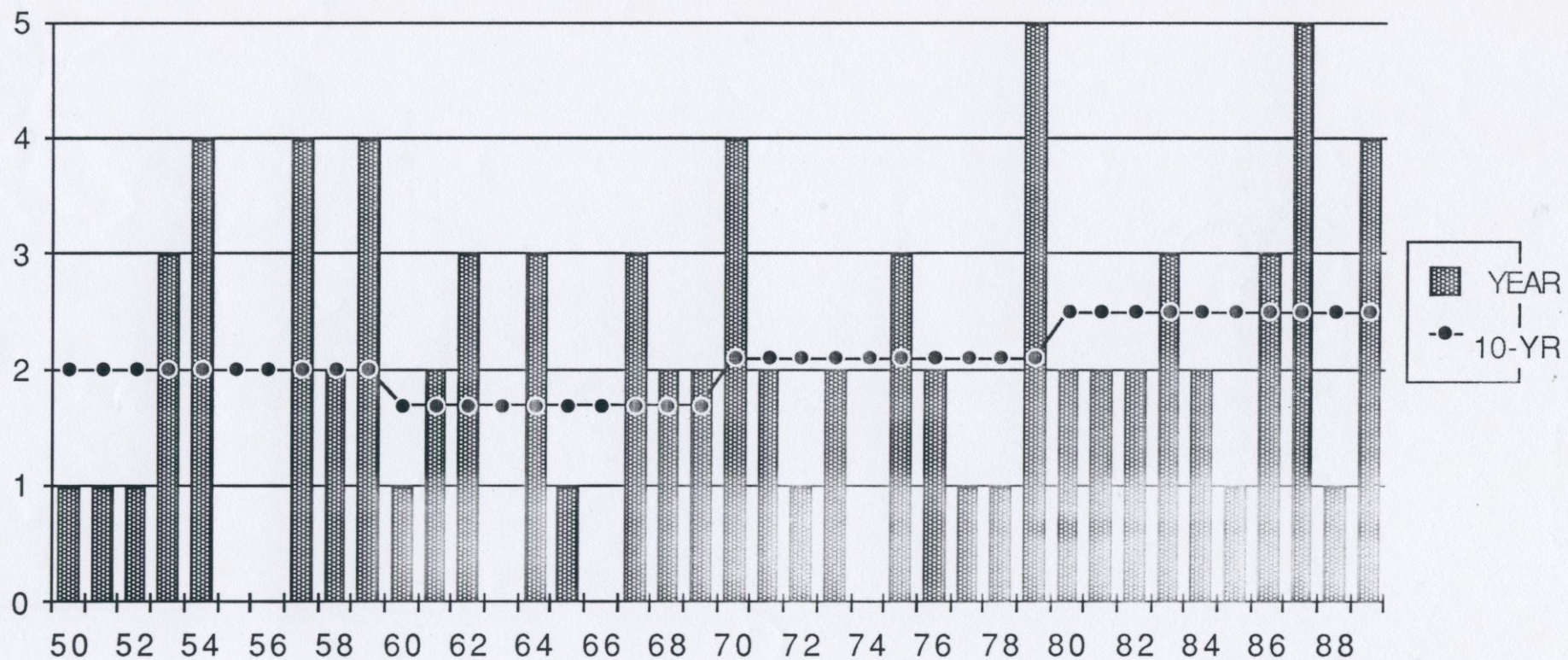


Figure 5